MASTER OF SCIENCE
IN
SPACE SYSTEMS OPERATIONS

DETECTING AND MEASURING TEMPORAL PHENOMENON WITH HIGH RESOLUTION SATELLITE IMAGERY

Andrew J. Hittner-Captain, United States Army
B.S., United States Military Academy, 1994
Master of Science in Space Systems Operations-September 2003
Advisors: Richard Olsen, Department of Physics
Richard Harkins, Department of Physics

A new operating mode for imaging satellites has been developed. The non-imaging mode is designed to provide high temporal resolution data time varying targets. The idea is to use linear pushbroom arrays with kilohertz sampling rates to not only detect, but also measure the frequency of temporally varying targets. For satellite operations this will involve satellite slewing at a rate which cancels the effects of satellite orbital motion. This concept was explored with a laboratory simulation of an intended test target consisting of windmills at the Ponnequin Wind Farm in Colorado. Test images were acquired and processed using an inexpensive camera and MATLAB. Results indicate the approach is viable and should produce distinct and useful signatures in time and frequency domain analysis.

KEYWORDS: Temporal Phenomenon, Frequency Response, Satellite Imagery

ANALYSIS OF THE NASA SHUTTLE HYPERVELOCITY IMPACT DATABASE

Michael S. Stucky-Lieutenant, United States Navy
B.S., United States Naval Academy, 1996
Master of Science in Space Systems Operations-September 2003
Advisors: Eric L. Christiansen, NASA Johnson Space Center
Rudolf Panholzer, Space Systems Academic Group
Second Reader: CAPT Dan Bursch, USN, Space Systems Academic Group

A statistical analysis of the NASA Space Shuttle Hypervelocity Impact Database to find correlations between meteoroid and orbital debris (M/OD) impacts on the shuttle orbiter fleet and specific mission parameters: Inclination, Altitude, Duration and Year. M/OD impact data, regardless of location, particle type, or mission was examined first, followed by the subcategories of Window data, Radiator data, Reinforced Carbon-Carbon (RCC) data, and Flexible Reusable Surface Insulation (FRSI) data.

In an effort to characterize and evaluate the M/OD environment in low earth orbit, post-flight surveys of the shuttle orbiters are conducted to identify damage caused by hypervelocity impacts from M/OD. Survey analysis determines whether the impactor was a naturally occurring meteoroid or man-made orbital debris, as well as the impactor's size and impact velocity.

From the post-flight survey data, calculations on the number of impacts from specific particle diameters or specific particle materials are made and compared to mission parameters to help engineers design spacecraft for better mission efficiency by reducing the effects of M/OD impacts.

This thesis analyzes the NASA Space Shuttle Hypervelocity Impact Database, using regression analysis software, to find correlations between M/OD impacts on the shuttle orbiter fleet and mission parameters to draw conclusions on what is influencing vehicle damage.

KEYWORDS: Regression Analysis, Space Shuttle, Hypervelocity Impact, Meteoroid, Orbital Debris, Low Earth Orbit